Best Practices for Implementing BACnet in Your Facility

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Introducing Appin & Grant Wichenko

Appin Associates is a 37 year old consulting firm that specializes in:

- **Building Automation System (BAS) Design** including specification and commissioning with emphasis on BACnet-enabled controls.
- **Mechanical Systems Design** (HVAC, Boilers, Chillers) paying particular attention to the needs of the FM.

Grant Wichenko is a Professional Engineer. He is a member of:

- ASHRAE SSPC-135 (BACnet committee – voting member),
- Member of EL-WG and Chair of AP-WG
- SGPC-13 (BAS Guideline Specification committee – voting member)

Appin Associates was the first Engineering firm to join BACnet International.
Learning Objectives
Best Practices for Implementing BACnet in Your Facility

1. Be able to explain the differences in BACnet’s networking technologies and their impact on BAS design.

2. Be able to explain the responsibilities of the various roles of the FM, in implementing BACnet in a project.

3. Understand how the principles of the Networked Controls Design Model will help to ensure a successful BACnet implementation and meet policy targets.
1. BACnet is the Building Device Interoperability Solution

Optimized Maintenance

FMs want their staff to be able to talk to devices from different equipment suppliers on a common network to streamline the management of their facilities.
1. BACnet is the Building Device Interoperability Solution

Utility Monitoring/Real Time Pricing

Meter data can be used for optimizing systems to improve maintenance and real time pricing.

The data can be displayed on a kiosk in the entrance to inform the occupants and the public on the Enterprise GREEN strategy progress.
1. BACnet is the Building Device Interoperability Solution

Emergency Response

BACnet data from devices can provide information to emergency responders that can be used during various emergency scenarios including weather events, fire, power outages, active shooter, bomb threats or other emergency situations.
2. Roles & Responsibilities in a Multi-Vendor BACnet-Based BAS Controls Environment

1. Networked Most organizations have three entities who have a hand in a project. These entities include:
   - Construction Manager
   - Facility Manager
   - Utility Manager

2. Depending on the size of the organization, the three roles could be one or more persons or department units.
2. Responsibilities | Construction Manager

1. The Construction Manager normally builds the project.

2. This includes:
   • Hiring and supervising the work of the Consultants.
   • Reviewing plans and specs.
   • Bidding the job out (either publicly or to an approved list or sole source)

3. The Construction Manager monitors the construction and pays claims.

4. The Construction Manager will negotiate changes to the original construction contract price

5. Eventually the job is completed and turned over to the Facility Manager to run.

6. The Utility Manager assumes responsibility for managing the whole building utility meters to the new building.
2. Responsibilities | Facility Manager

1. The Facility Manager is responsible for running the buildings in the portfolio.

2. The Facility Manager may also undertake minor construction projects that are maintenance related such as a boiler replacement or enhancements to existing facilities.

3. The Facility Manager has a critical role in the design, construction and commissioning of the building.
   - The FM needs to ensure that the design is consistent with other buildings and that the equipment comes with the necessary network connections and data points that allow for proper monitoring via the BACnet BAS.
   - The FM needs to participate in the construction process Submittal review to ensure equipment consistency with the department’s expectations.
   - The FM needs to review and participate the commissioning process to ensure that the equipment is operating properly before it is accepted by the Owner.
2. Responsibilities | Utility Manager

1. The Utility Manager is responsible for managing the utilities on Campus or on Base – the Facility Domain.

2. The Utility Manager’s department may also act as the utility that buys power and then charges back the cost of the power to the departments or residences on base.

3. The Utility Manager may undertake projects like new sub-stations, PV Arrays, new generators or may, in consultation with the Facility Manager, undertake energy projects where the savings pay for the capital cost.

4. Finally the Utility Manager may run a real time pricing plan that may involve shedding loads on selected buildings when the price of utilities change for a short period of time. This requires co-ordination with the Facility Manager to minimize disruptions to the occupants.
2. Roles and Responsibilities for Metering

1. The Construction Manager is responsible for ensuring that the whole building meters are correctly installed and commissioned.

2. The Construction Manager is also responsible for ensuring that the equipment requiring onboard metering via BACnet has been provided per the Contract Documents.

3. The Utility Manager is normally concerned about the cost of the utility as seen by the building owner. This may include real time pricing strategies.

4. The Facility Manager is concerned about the utility cost at the equipment or plant level to satisfy the occupants needs in a cost-effective manner.

5. Having both equipment level metering and whole building metering is critical to the proper operation of the buildings in the Facility Domain.
2. Both Equipment Level and Whole Building Metering by the BAS are Essential

Equipment Level Metering
• This is essential for FMs to maintain proper performance over the life of the system.
• Most pieces of equipment – VFDs, chillers, CRACs, Trip Units – now have onboard metering via BACnet.
• While the meter data is not revenue grade per ANSI C 12.19, daily metering will tell the FM how the chiller, boiler, AHU and other plants are doing.

Whole Building Metering
• These meters allows the FM and the UM to track consumption and demand over time to plan for expansions or to confirm the long term success of a retrofit.
2. Roles and Responsibilities for Metering

1. Are the utility meters (gas, water, electricity) on the BACnet BAS?

2. Have the boilers, chillers, VFDs etc. been specified to come with onboard metering via BACnet?

3. The **Construction Manager** ensures that the correct meters are provided and that the data is brought into the BAS either as pulse points or BACnet network points.

4. The **Facility Manager** is concerned about using the meter data to optimize operations. This is normally a 7 day to 3 month time horizon.

5. The **Utility Manager** is concerned about tracking total demand and consumption to plan for substation expansion and use of alternative sources such as PV, generators. The UM is also concerned about using the data to make bulk buys with the local utility and for real time pricing. The UM looks at multi-year meter data.

6. If Equipment Level and Whole Building metering is done correctly, the meter data can also be aggregated and summarized and then presented in an Energy Dashboard that can be used the CM, UM or FM as well as other roles in the organization.
Boiler plant changed in 2011 to condensing

Owner negotiated a better gas price in 2012

CO₂ Emissions declining

2. Building Level Meter Data is CONFIRMATORY

Allows you to determine project priorities and to document performance over time
Running cost to operate plant.

M-F 24 hour total.

S-S 24 hour total.

Simple alarming for Fac Ops.

Graphics like this chiller plant help Facilities Operations correct problems in real time. The meter data here is from meters via the BACnet Interface Devices and the current transducers.
2. Equipment Meter Data is ACTIONABLE
Shows the history, current status and improvements

Where we have been. Total Chiller plant daily kWh in RED. OAT in BLUE.

Where we are right now. .7 kW/Ton

Regression Analysis of OAT vs. total Chiller kWh – Where we can do better.
3. BACnet-based Networked Controls Design Model in a Construction Contract

1. A BACnet-Based BAS Networked Controls Design Model is based on the principle that the equipment provided by the electrical, fire, security, lighting and other trades must come with BACnet on-board.

2. The Design Consultant’s Equipment Specification must tell the Equipment Supplier that he is responsible for the BACnet interface. This is not the responsibility of the BAS trade nor third parties. Field installed gateways that are not authorized by the equipment supplier are not allowed.

3. There is a clear line of responsibility between the device supplier and BAS vendor who is responsible for monitoring or controlling the equipment.
3. BACnet-based Networked Controls Design Model in a Construction Contract

4. There are safeties, standards and other code requirements that must be respected. Making a network connection instead of hard wiring to the device or fitting controls on the device by others, respects these requirements.

5. While some devices will be native BACnet devices, many devices will speak a proprietary protocol, thus requiring a gateway. The Networked Controls Model requires that the Equipment Supplier shall provide the gateway as a factory approved BACnet Interface Device or shall arrange for an authorised third party to provide the controls.
3. BACnet-based Networked Controls Design Model in a Construction Contract

6. If there are unique power requirements or hardwired sensors, these too, shall be provided by the Equipment Supplier. This is necessary so that Equipment Suppliers that have native BACnet devices powered from a single Point of Connection are equal to a competitor who has an outboard BACnet device or devices, all of which require separate power.

7. Proprietary protocol wiring to connect the devices is by the Equipment Supplier. This includes ARCNET, PTP, LonTalk and ZigBee.

8. BACnet MS/TP wiring is by the Division 25 BAS Contractor.

9. BACnet/IP wiring is by the Owner’s IT department or Division 27. No IP wiring is by Division 25.
3. Clear Roles and Responsibilities are Key

A properly designed outline of roles and responsibilities covers:

1. Who supplies the BACnet device
2. Who installs the BACnet device
3. Who networks the BACnet device
4. Who provides the external power
5. Who does the network wiring
6. Who wires the safeties
7. Who tests and commissions the device
8. If it is an IP device, who assigns the IP address
9. Who assigns the BACnet instance number.
3. IT Support is Essential

1. Most FMs must rely on IT for access to the Enterprise LAN. IT must become “your new BFF (Best Friend Forever)”.

2. IT must be involved with the BAS integration when the job starts, not a week before commissioning begins. Give IT plenty of time to provide switches, patch panels and IP addresses.

3. Other than BACnet/NS Devices that are secure, BACnet Devices and networks are secured by IT means. We must follow IT security rules.

4. IT security also includes no open connections in public areas, physical security to rooms where BAS equipment is installed and mandatory FM staff/contractor security clearances or background checks.

5. Servers, switches and IP cabling infrastructure are to IT standards…no more unmaintained computers and rogue hubs in Mechanical Rooms!!!
6. Having separate computers with Front Ends for each job are no longer required. More computers create extra patch management work for IT.

7. The servers should be provided as Virtual Machines that are maintained by IT, not FM nor the BAS vendor.

8. BAS must follow IT cabling installation standards or cabling is done by Division 27. Only BACnet MS/TP and Modbus cabling is by the BAS vendor.

9. There should only be one network connection from the BAS Device network to the Enterprise LAN. This allows for a functioning BAS network until IT completes the certification and accreditation process (ATO for DoD).

10. BASs are now commissioned using the IP infrastructure. IT may be asked to allow a temporary wireless network so MEP and finish their work. This would be removed once the Building it lit up and online.
3. Construction Roles & Responsibilities

1. The BACnet-Based BAS model is based on the principle that the equipment provided by the electrical, fire, security, lighting and other trades must come with a BACnet Interface Device on-board.

2. The BACnet interface gets approved via the Submittal process like the color, weight and electrical requirements.

3. The Mechanical and Electrical Subtrades must ensure that there are acceptable Submittals and that the equipment and the BACnet interface are installed and commissioned properly.

4. The General Contractor, who is the only party to the Construction Agreement, must take overall responsibility of this Work to ensure that it is done per the Plans and Specifications.

....How do we do this successfully?
3. A Boiler Plant that Includes Devices with BACnet on Board and Stick-built Points

1. A boiler plant is composed of BACnet devices, including:
   • Boilers and a boiler manager
   • VFDs on pumps
   • Hardwired sensors
   • Hardwired safeties

2. All of these devices need to be integrated together as a single BACnet based Boiler Plant.

3. There should be one Trade responsible for integrating the Plant controls together. The most likely trades to do this Work are the BAS trade or the boiler supplier working as a sub-trade to Mechanical.
3. A Boiler Plant that Includes Networked and Stick-built Devices

The boiler plant consists of a plant controller BACnet device, single on-board BACnet devices for the VSDs and stick built sensors and other devices supplied and installed by Division 25.

This is an example of a Built-up BACnet Device.
### 3. The Responsibility Matrix

Defines who does what on the job

| Responsibility Matrix: Built-Up BACnet Interface Device Option. See Section 25 00 13 for definitions. |
|---|---|---|---|---|---|---|---|---|
| Week Item | Construction Management | Power Wiring | Communication Wiring | Software and Programming |
| | Submit documentation for approval | Participant Provide Assistance | Complete | From the Panelboard to the Power Drop | From the Power Drop to the Device | From the BACnet Device to the Supplier’s Equipment | From the Supplier’s Equipment | Supervisory Control |
| Native BACnet device (all data link/network layer options) required to make the supplier’s equipment operational and networkable to the BACnet Internetwork | Specific Division | Specific Division | Specific Division | Specific Division | 26 | 26 | 26 | 25 |
| BACnet Interface Device required to convert proprietary protocols and to map proprietary data points to the BACnet Internetwork | Specific Division | Specific Division | Specific Division | Specific Division | 26 | 26 | 26 | 25 |
| Any proprietary (non-BACnet) software, computer, printer, cables, USB keys or any other devices required to make the supplier’s equipment operational | Specific Division | Specific Division | Specific Division | Specific Division | N/A | N/A | N/A | N/A |
| Provide programming or configuration of the supplier’s control panel and/or BACnet Interface Device to meet the Sequence of Operations | Specific Division | ALC | ALC | ALC | ALC | ALC | ALC | ALC |
| Provide control, graphics, trends, alarms, schedules for this BACnet Interface Device on the BACnet Internetwork | ALC | ALC | ALC | ALC | ALC | ALC | ALC | ALC |
| Network connection to the BACnet Internetwork | 27 for BACnet/IP and 25 for BACnet MS/TP | 27 for BACnet/IP and 25 for BACnet MS/TP | 27 for BACnet/IP and 25 for BACnet MS/TP | 27 for BACnet/IP and 25 for BACnet MS/TP | 27 for BACnet/IP and 25 for BACnet MS/TP | 27 for BACnet/IP and 25 for BACnet MS/TP | 27 for BACnet/IP and 25 for BACnet MS/TP | 27 for BACnet/IP and 25 for BACnet MS/TP |
3. BACnet Language Adders
Defines the BACnet Interface Device Work Scope

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section, including General and Supplementary Conditions and Division 01 Specification Sections.

B. Section 25.20.23.52.16 Integrated Automation – BACnet Interface Device (Gateways/Native BACnet Devices) – Condensing Boilers (All Types)

General:

Products:

Execution:

Installation of Equipment BACnet Interface Device

1. See Responsibility Matrix for the execution responsibilities for Equipment Supplier, Controls and Electrical Subcontractor.

2. Equipment Supplier is responsible for supplying and installing the BACnet Interface Device.

3. Electrical is responsible for power and any control wiring if the device does not have a single point of connection.

4. Division 25 is only responsible for communicating with the Boiler BACnet Interface Device Plant Controller using BACnet objects and services to access this data
### 3. Trade Responsibilities & BACnet Object List

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1. **GENERAL**

1.01 → **CONTROLS COORDINATION MEETING**

These are the Boiler BACnet object lists, fault codes, supply water setpoint, etc.
3. A Single Line Diagram
Shows which Trade does what in a simple graphic
Concluding Remarks
Best Practices for Implementing BACnet in Your Facility using the Networked Controls Design Model

1. BACnet offers a range of networking technologies to meet your needs.

2. The CM, the FM and the UM all have important roles in implementing BACnet projects.

3. Equipment level using BACnet is critical to managing a facility and whole building metering is needed to document performance.

4. The Networked Controls Design Model implements BACnet projects properly within the confines of a standard Construction Contract.

5. BACnet International offers a course on the Networked Controls Design Model.
Questions?